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EUGENIA GS INTAKE STRUCTURE CONCRETE INVESTIGATION

Report Number 88-151-K

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ABSTRACT

An investigation into the condition of the concrete forming the Intake Structure at Eugenia GS indicates that the concrete has severely deteriorated due to freeze-thaw action and ice abrasion.

More detailed investigation and remedial action is recommended.

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To: Mr. J.V. Doyle
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Attn: Mr. T.W. Frost

EUGENIA GS INTAKE STRUCTURE
CONCRETE INVESTIGATION

1.0 INTRODUCTION

At the request of Mr. T.W. Frost of the Civil Works Department, an investigation of deteriorated concrete at Eugenia GS Intake Structure was conducted on April 13, 1988, by the Concrete Technology Section, Civil Research Department. The investigation consisted of visual observations and concrete coring to obtain specimens for laboratory testing.

The results of the investigation, including the laboratory testing of the concrete cores, are given in this report.

2.0 VISUAL OBSERVATIONS

Due to the high water level at the upstream face of the structure and because the majority of the downstream face is backfilled, only limited visual observations could be made.

The exposed concrete above the waterline (1.5 m) is severly spalled and pitted (Figure 1). At some locations, reinforcing steel has been exposed. An area of severe deterioration, east of the gatehouse at the waterline, has been covered with a steel plate anchored into the upstream face of the structure. Severe spalling of the top of the structure near the gatehouse is also occurring (Figure 2). Below the waterline, the condition of the concrete could not be determined.

To investigate the condition of the downstream face, east of the gatehouse, an area, 2.1 x 2.1 x 1.8 m, was excavated behind the dam (Figure 3). The excavation was limited to a depth of 1.8 m due to water seeping though the concrete. A visual inspection of this exposed section revealed two major cracks, 6 mm and 1.6 mm wide. The larger crack contained deposits on the surface, probably from water leaching salts from the concrete. This area also had numerous hairline cracks.

3.0 CONCRETE CORING

3.1 Procedure

To obtain samples for laboratory testing and evaluation, coring was performed on the exposed area.

The concrete core drilling was performed with a 100 mm nominal diameter water-cooled diamond bit drill. A total of four cores were drilled east of the gatehouse, three horizontally in the area excavated downstream of the structure and one vertically from the top. The horizontal cores were drilled to determine the depth of concrete deterioration. The vertical core was taken on apparently sound concrete for comparison purposes.

A core log is given in Table 1. Figure 4 shows the cores as they were received in the laboratory.

3.2 Laboratory Testing

The laboratory portion of the investigation consisted of selecting sections of the cores and testing these in accordance with the applicable CSA or ASTM standards for the following properties:

-	Compressive Strength	CSA A23.2
-	Density	ASTM C 642
-	Absorption	ASTM C 642

A summary of the test results is given in Table 2. The average compressive strength and density are 38.0 MPa and 2374 kg/m^3, respectively. The absorption average is 7.4%, ranging between 4.2% and 12.1%.

4.0 CONCLUSIONS

Based on the visual observations and laboratory testing, it is evident that deterioration of the concrete is taking place. The damage to the structure consists primarily of large cracks and spalled sections which have exposed reinforcing steel. The damage is most severe at the waterline and is probably the result of frequent freeze-thaw cycling when the concrete is saturated. There is also evidence of erosion from water and ice action. From the cores, it is evident that the damage due to freeze-thaw action extends almost through the entire thickness of the structure. This process is progressive and may accelerate as a result of cracking and corrosion of exposed reinforcing steel.

5.0 RECOMMENDATIONS

Since the damage observed is extensive, remedial action should be taken as soon as possible.

To investigate the full extent of the deterioration and to determine the structural integrity, partial dewatering of the headpond and partial excavation of the downstream face should be carried out.

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HC:sc

TABLE 1

Eugenia GS Intake Structure

Core Log

Core No.	Location	From-To (mm)	Ident.	Decription
1.	Drilled vertically from the top, 11.80 m east of gatehouse.	0-180	1-1	- fair concrete - max aggregate size 40 mm
		180-410	1-2	- fair concrete - max aggregate size 40 mm
		410-510	1-3	- core not recovered
2.	Drilled horizontally from downstream, 1.80 m east of gate-house, 1.35 m from the top.	0-255	2-1 & 2-2	- fair concrete - max aggregate size 40 mm - leachate deposit on surface over crack in core - numerous cracks in core - structure thickness at this location is 250 mm. 100 mm eroded from upstream face
3.	Drilled horizontally from downstream, 1.65 m east of gate-house, 1.15 m from the top.	0-180	3-1	- fair concrete - max aggregate size 40 mm
		180-280	3-2	- fair concrete - core broken into 3 pieces - stopped at reinforcing steel
4.	Drilled horizontally from downstream, 1.95 m east of gate-house, 0.90 m from the top.	0-160	4-1	- poor concrete, damaged through entire structure thickness - max aggregate size 40 mm
		160-320		- poor recovery - rubble

T A B L E 2

Eugenia GS Intake Structure

Test Results on Concrete Cores

Identification	Compressive Strength, MPa	Density Kg/m^3	Absorption %
1-1	42.8	2327	7.0
1-2	33.9	2413	5.6
2-1	-	2277	8.3
2-2	-	2294	10.2
3-1	37.4	2442	4.2
3-2	-	2407	6.8
3-3	-	2549	4.6
4-1	-	2281	12.1
Average	38.0	2374	7.4

Figure 1: Eugenia GS Intake Structure. Severe concrete deterioration has occured at the waterline. At one location, near the gatehouse, a steel plate has been used to cover spalled concrete.

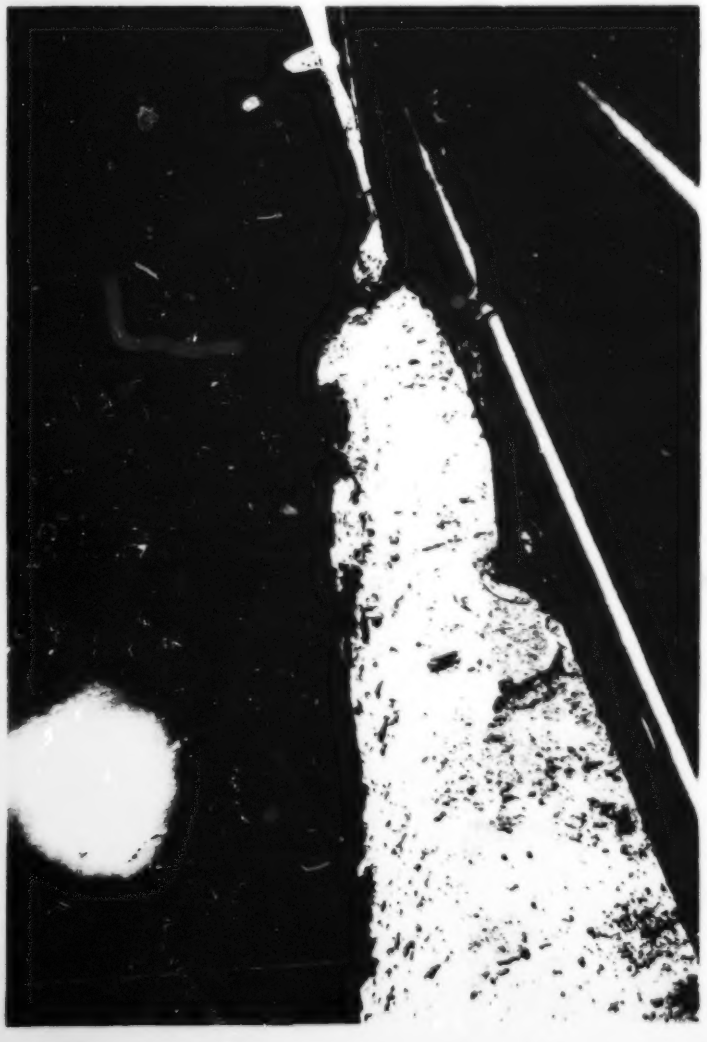

Figure 2: Top of the structure, east of the gatehouse, showing the spalled concrete and exposed reinforcing steel.

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Figure 3: Excavated area downstream, east of the gatehouse. Note cracks and deposits on the concrete surface.

Figure 4: Concrete cores as received in the laboratory. Core 1 was drilled vertically from the top and Cores 2 to 4 were drilled horizontally on the downsteam face.